SWR-01-SA-5638:HLB

MEMORANDUM FOR: The Record, SWR-01-SA-5638:HLB

FROM: Rodney R. McInnis
Acting Regional Administrator

SUBJECT: Endangered Species Act section 7 biological opinion on the issuance of a section 10(a)(1)(A) scientific research permit for take of endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon, and threatened Central Valley steelhead.

I. CONSULTATION HISTORY

The National Marine Fisheries Service's (NOAA Fisheries) participation in the development of the proposed project began on December 20, 2002, at a meeting of the North Delta Fish Facilities Technical Team (NDFFTT) held at the Department of Water Resources (DWR) Ecological Services Office (ESO). At this meeting, the NDFFTT discussed the development of a project plan to pass adult salmon from the Sacramento Deep Water Ship Channel (SDWSC) through the W.G. Stone Lock, in West Sacramento, Yolo County, California, to the main channel of the Sacramento River. DWR Environmental Specialist Maureen McGee distributed a draft project plan to team members for review. Following the meeting, NOAA Fisheries Fishery Biologist Howard Brown contacted Ms. McGee by telephone and provided comments. These comments focused on Endangered Species Act (ESA) consultation issues, including the need for take coverage, an estimation of the take involved, and the need for the project plan to address measures to minimize take.

In early January, Patti Quickert of DWR’s permitting branch contacted Mr. Brown to discuss ESA section 7 consultation requirements and timelines, and on February 11, 2002, a multi-agency project coordination meeting was held at DWR ESO. In attendance were Maureen McGee, Andrew Frankel, and Mike Allan of DWR; David Cole, Jill Russi, James Sandner, and Penny Caldwell of the U.S. Army Corps of Engineers (Corps); Kerry Wicker and Anna Holmes of the California Department of Fish and Game (DFG); and Howard Brown. Ms. McGee and Mr. Frankel gave an overview of the project, and others discussed various agency needs and requirements for initiating the project. Mr. Brown provided DWR, the Corps, and DFG with a synopsis of section 7 consultation processes and requirements.

On April 23, 2002, the Corps requested formal consultation with NOAA Fisheries to evaluate the impacts of the proposed SDWSC Fish Passage Project on endangered Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), threatened Central Valley spring-run Chinook salmon (*O. tshawytscha*), threatened Central Valley steelhead (*O. mykiss)*, and their respective designated critical habitats. Included in the initiation package was the April 5, 2002 version of the SDWSC Fish Passage Plan. This plan serves as the Biological Assessment (BA) for the project.

In mid-August, 2002, NOAA Fisheries determined that although the project involved a Federal agency, the action involved the direct, intentional take of listed salmonids for scientific research and should, therefore, be permitted in accordance with section 10 (a)(1)(A) of the ESA.

On August 29, 2002, Howard Brown and NOAA Fisheries ecologist Rosalie del Rosario met with Maureen McGee to discuss permitting the project under section 10 (a)(1)(A) of the ESA.

On September 6, 2002, DWR submitted a section 10 (a)(1)(A) permit application to NOAA Fisheries for the proposed project. This application included an updated take estimate for adult and juvenile salmonids.

On April 28, 2003, Howard Brown met with Maureen McGee to discuss recent changes to the anticipated field sampling schedule and take estimates. Take estimates were also updated to include injury estimates.

A complete administrative record of this consultation is on file at the NOAA Fisheries Sacramento Area Office, 650 Capitol Mall, Suite 8-300, Sacramento, California 95814.

II. DESCRIPTION OF THE PROPOSED ACTION

NOAA Fisheries proposes to issue a research permit pursuant to section 10 (a)(1)(A) of the ESA, for take by DWR of endangered Sacramento River winter-run Chinook salmon, threatened Central Valley spring-run Chinook salmon (CV spring-run Chinook salmon), and threatened Central Valley steelhead (CV steelhead) from the SDWSC Fish Passage Project. The purpose of the proposed research activity is to design, implement, and evaluate fish passage technologies involving boat locks. There currently is a lack of detailed information on how the upstream migration of adult Chinook salmon and steelhead might react to upstream fish passage facilities within the Sacramento-San Joaquin Delta (Delta). The NDFFTT and the Through Delta Facilities Technical Team are studying fish passage alternatives for potential future water export projects in the Delta. Although such a facility can be screened to prevent entrainment of juvenile salmonids, adult salmonids may become attracted to the back side and require an upstream passage facility to complete their migration. The proposed fish passage project will serve as a pilot for evaluating the effectiveness of using lock gates as an upstream fish passage facility.

The work will be conducted at the W.G. Stone Lock in the SDWSC beginning in May, 2003, and continuing through May, 2005. The W.G. Stone Lock connects the SDWSC to the Sacramento River via the SDWSC barge channel near Sacramento River Mile (RM) 57. From this point, the SDWSC continues southwest approximately 25 miles before it connects with the Sacramento River upstream of Rio Vista at RM 14.

The SDWSC is an artificial channel created in 1963 to accommodate deep-draft ocean going vessels from Suisun Bay to an inland harbor at West Sacramento. It consists of two sections, Suisun Bay to Cache Slough (lower section), and Cache Slough to West Sacramento (upper section). The lower section is approximately 18 miles long and is largely within the main channel of the lower Sacramento River. The upper section is entirely man-made and bisects a 25 mile long area east of Cache Slough and west of the Sacramento River. The upper section consists of the ship channel, a triangular harbor and turning basin called Washington Lake, and a barge canal and navigation lock from the harbor to the Sacramento River for transfer of barges between waterways. The upper ship channel is 30 feet deep and varies from 200 to 300 feet wide.

Experiments conducted throughout the year under two scenarios will be used to test fish passage through the W.G. Stone Lock. In Scenario 1, the downstream and upstream gates of the lock will open sequentially, whereas in Scenario 2 the gates will open concurrently. Specifically, Scenario 1 will involve opening the downstream gates for one, two, or three hours to allow fish to move into the lock, then closing the gates for approximately 30 minutes to stabilize water movement inside the lock, and finally opening the upstream gates for one, two, or three hours to allow fish to continue upstream past the lock. Scenario 2 will involve opening both the downstream and upstream gates a distance of two, four, or six feet for a period of one, two, or three hours. The time period of open gate operation and gate height will vary as indicated above in order to identify a combination of lock operations that will maximize fish passage through the entire lock system.

Information on seasonal fish species composition, size, and distribution within the water column will be obtained through fish sampling supplemented with angler creel surveys. Data on fish passage through the lock gates will be collected through a combination of fish sampling, including mark-and-recapture surveys, and hydroacoustics. During experiments, the lock will be operated three days per week and fish sampling and hydroacoustics work will occur four days per week, during both the day and night. Hydroacoustic transducers will be positioned downstream, within, and upstream of the W.G. Stone Lock.

Fish sampling will be conducted using trammel nets to target salmon, splittail, American shad, and striped bass; gill nets to target white sturgeon; and purse seines to target small, surface-oriented fish. Adult salmon and steelhead captured in nets downstream of the W.G. Stone Lock will be marked with a dorsally-inserted floy tag and then released. Marked fish will be recaptured in trammel nets in the SDWSC upstream of the lock.

Trammel nets consist of three layers of cotton or nylon net panels suspended vertically from a single float line by attaching the panels to a single lead line along the net bottom. Two large-mesh outer panels encase a fine-mesh inner panel. The inner panel is longer and hangs loosely between the outer panels, forming a bag or soft pocket of netting (Murray 1983). The bag allows fish to be entangled rather than gilled, subsequently minimizing stress and injury. The trammel nets used in this study will have an inner stop panel of 2-inch stretch mesh, and an outer panel of 12-inch stretch mesh. One trammel net will be used downstream of the lock and one will be used upstream of the lock. Deployed trammel nets will be retrieved and inspected at 20 minute intervals.

Gill nets are single panel walls of netting, typically constructed of monofilament line, suspended vertically from a float line by using a lead line along the net bottom. Gill nets used in this study will measure 10 feet deep by 80 feet long. One-half of each net (i.e., 40 feet of the length) will have 6-inch stretch mesh, and the other half will have 10-inch stretch mesh. The gill nets will be anchored so as to lie along the bottom of the channel in order to target sturgeon and avoid salmon and steelhead. One gill net will be used downstream of the lock and one will be used upstream of the lock. Deployed gill nets will be retrieved and inspected at 20-minute intervals.

A purse seine is a net that is suspended vertically from a float line by using a lead line along the net bottom, and set around the circumference of a target area. Once the target area is enclosed, the bottom of the purse seine is drawn shut with a string. Purse seines used in this study will be 10 feet deep by 100 feet long, and constructed of 3/16-inch extra-heavy mesh. One purse seine will be used downstream of the lock and one will be used upstream of the lock. Purse seines will be retrieved and inspected immediately following deployment. Juvenile salmon and steelhead captured in purse seines will be released at the capture location.

DWR anticipates that the SDWSC Fish Passage Project will result in adult and juvenile take from capture, injury, and mortality that will not exceed the amount shown in Table 1. This level represents DWR's take estimate based on the best available information, including past or ongoing fishery research projects conducted in the Delta Cross Channel, Georgiana Slough, and Suisun Bay.

In order to minimize effects to listed anadromous species, DWR proposes to coordinate with NOAA Fisheries and the Data Assessment Team (DAT) and suspend research activities and close the W.G. Stone Lock when significant pulses of juveniles are migrating past the action area in the Sacramento River. The DAT consists of biologists from the Central Valley Project (CVP) and State Water Project (SWP) Operation Group, including representatives from NOAA Fisheries, U.S. Fish and Wildlife Service (FWS), DWR, and DFG, who compile and interpret fishery-related data and make recommendations on water management that benefit fisheries.

Specifically, several measures will be taken to minimize the take of take of listed winter-run Chinook salmon, spring-run Chinook salmon and CV steelhead. To minimize the stress and mortality of adult and juvenile winter- and spring-run Chinook salmon and steelhead DWR will ensure that:

1. Field Assistants working on the SDWSC Fish Passage Project shall have at least one year of field experience with capturing and handling juvenile and adult anadromous fish or be trained by DWR environmental scientists with at least five years of such field experience.

2. Any listed Chinook salmon or steelhead that is unable to maintain an upright position following capture shall not be tagged and must be resuscitated to the maximum extent practicable and immediately released.

3. If adult take estimates are exceeded for the periods identified in the take estimate table (Table 1), the project shall be suspended and NOAA Fisheries shall be notified within 24 hours, or on the next working day.

4. If adult take estimates are exceeded for the periods identified in the take estimate table (Table 1), the project shall be suspended and NOAA Fisheries shall be notified within 24 hours, or on the next working day.

To minimize the diversion of juvenile winter- and spring-run Chinook salmon and steelhead into the SDWSC DWR will:

1. Notify NOAA Fisheries prior to opening the W.G. Stone Lock gates when Sacramento River flows, measured at the Verona gauge, exceed 15,000 cfs between November 15 and January 1. The gauge at Verona can be accessed at http://cdec.water.ca.gov/river/lsacto2Stages.html. Opening the W.G. Stone Lock gates will be subject to NOAA Fisheries approval pending review of the most recent outmigrant data.

To minimize attraction of adult winter- and spring-run Chinook salmon and steelhead to the SDWSC DWR will:

1. Ensure that the W.G. Stone Lock gates are kept closed when Sacramento River flows, measured at the Verona gauge, exceed 60,000 cfs. The gauge at Verona can be accessed at the following website: http://cdec.water.ca.gov/river/lsacto2Stages.html.

Based on the expected capture and handling of listed salmonids, NOAA Fisheries proposes to authorize the take of listed salmonids as described in Table 1.

Table 1.- Adult and juvenile Chinook salmon and steelhead direct take anticipated from fish sampling activities for the Sacramento Deep Water Ship Channel Fish Passage Project at the W.G. Stone Lock, in West Sacramento, for the 2003 - 2005 field seasons.

Estimates for 2003	Time of Year Adult Fish are Present	Total Adult Take Estimates[1]	Adult Injury Estimates[2]	Adult Lethal Take Estimates	Time of Year Juvenile Fish are Present	Total Juvenile Take Estimates	Juvenile Injury Estimates	Juvenile Lethal Take Estimates
Winter-run Chinook Salmon	April-Jun & Nov-Dec	96	94	2	April-Jun & Sep-Dec	27	5	1
Spring-run Chinook Salmon	April to August	72	70	2	April-Jun & Oct-Dec	24	5	1
Central Valley Steelhead	April & Aug-Dec	49	47	2	April-May & Dec	6	1	1
Estimates for 2004								
Winter-run Chinook Salmon	Jan-Jun & Nov-Dec	96	94	2	Jan-Jun & Sep-Dec	27	5	1
Spring-run Chinook Salmon	March to August	72	70	2	Jan-Jun & Oct-Dec	24	5	1
Central Valley Steelhead	Jan-Mar to Aug-Dec	49	47	2	Jan-May & Dec	6	1	1
Estimates for 2005								
Winter-run Chinook Salmon	Jan-Jun & Nov-Dec	40	38	2	Jan-Jun & Sep-Dec	15	3	1
Spring-run Chinook Salmon	March to August	36	34	2	Jan-Jun & Oct-Dec	7	1	1
Central Valley Steelhead	Jan-Mar to Aug-Dec	25	23	2	Jan-May & Dec	4	1	1

[1] includes capture, injury and mortality

[2] 100% injury rate because all adult fish will be tagged

Adult and juvenile lethal and non-lethal take from fish capture and handling activities of the SDWSC Fish Passage Project is not expected to exceed the amount shown in Table 1. Take also is expected to include all rearing or outmigrating Chinook salmon or steelhead harmed, harassed, or killed from being diverted into the SDWSC from the Sacramento River due to operation of the W.G. Stone Lock. This take may result from the research periodically disrupting the normal migratory behavior of juveniles, or subjecting diverted juveniles to poor habitat conditions and increased probability of predation in the SDWSC.

Finally, take is expected to include all migrating adult Chinook salmon or steelhead harmed from being falsely attracted into the SDWSC from Cache Slough due to operation of the W.G. Stone Lock. This take may result from the research periodically disrupting the normal migratory behavior of adults.

NOAA Fisheries anticipates that take of juvenile and adult Sacramento River winter-run Chinook salmon, CV spring-run chinook salmon, and CV steelhead from lock operation will be difficult to quantify because the likelihood of detecting dead or impaired specimens is small. However, lock operation is not expected to exceed three days per week, year-round from October 2002 through May 2004. Lock operation is not expected to occur at all whenever Sacramento River flow exceeds 60,000 cfs, measured at Verona, or 15,000 cfs from November 15 through January 1.

III. STATUS OF THE SPECIES AND CRITICAL HABITAT

This biological opinion analyzes the effects of the SDWSC Fish Passage Project on the following threatened and endangered species:

- Sacramento River winter-run Chinook salmon - endangered
- Central Valley spring-run Chinook salmon - threatened
- Central Valley steelhead - threatened

No designated critical habitat occurs in the area affected by the proposed action.

A. Sacramento River Winter-Run Chinook Salmon

1. <u>Background and Life History</u>

Sacramento River winter-run Chinook salmon were originally listed as threatened in November, 1990 (55 FR 46515). This status was reclassified as endangered in January, 1994 (59 FR 440) due to continuing decline and increased variability of run sizes since their listing as a threatened species, expected weak returns as a result of two small year classes in 1991 and 1993, and continuing threats to the population. NOAA Fisheries recognized that the population had dropped nearly 99% between 1966 and 1991, and despite conservation measures to improve habitat conditions, the population continued to decline (57 FR 27416). A draft recovery plan was published in August 1997 (NMFS 1997).

Winter-run Chinook salmon historically spawned in the headwaters of the McCloud, Pit, and Little Sacramento rivers and Hat and Battle creeks. Construction of Shasta Dam in 1943 and Keswick Dam in 1950 blocked access to all of these waters except Battle Creek, which is blocked by a weir at the Coleman National Fish Hatchery and other small hydroelectric facilities (Moyle 1989, NMFS 1997). Most of the current winter-run Chinook salmon spawning and rearing habitat exists between Keswick

Dam and Red Bluff Diversion Dam (RBDD) in the Sacramento River.

Adult winter-run Chinook salmon enter San Francisco Bay from November through June (Hallock and Fisher 1985) and migrate past RBDD from mid-December through early August (NMFS 1997). The majority of the run passes RBDD from January through May, and peaks in mid-March (Hallock and Fisher 1985). Generally, winter-run Chinook salmon spawn from near Keswick dam, downstream to Red Bluff. Spawning occurs from late April through mid-August with peak activity between May and June. Eggs and pre-emergent fry require water temperatures at or below 56º F for maximum survival during the spawning and incubation period (FWS 1999). Fry emerge from mid-June through mid-October and move to river margins to rear. Emigration past RBDD may begin in mid-July, typically peaks in September, and can continue through March in dry years (NMFS 1997, Vogel and Marine 1991). From 1995 to 1999, all winter-run Chinook salmon outmigrating as fry passed RBDD by October, and all outmigrating pre-smolts and smolts passed RBDD by March (Martin et al. 2001).

2. Population Trends

Since 1967, the estimated adult winter-run Chinook salmon population ranged from 186 in 1994 to 117,808 in 1969 (DFG 2002). The estimate declined from an average of 86,000 adults in 1967-1969 to only 2,000 by 1987-1989, and continued downward to an average 830 fish in 1994-1996. Since then, estimates have increased to an average of 3,136 fish for the period of 1998-2001. Winter-run Chinook salmon abundance estimates and cohort replacement rates since 1986 are shown in Table 1. Although the population estimates display broad fluctuation since 1986 (186 in 1994 to 5,523 in 2001), there is an increasing trend in the five year moving average over the last five year period (491 from 1990-1994 to 2609 from 1997-2001), and a generally stable trend in the five year moving average of cohort replacement rates. The 2001 population was the highest since the listing, with an estimate of 5,521 adult fish.

Table 2.- Winter-run Chinook salmon population estimates from Red Bluff Diversion Dam counts, and corresponding cohort replacement rates for years since 1986. Data Source: DFG 2002. Sacramento River Winter-run Chinook Salmon Biennial Report: 2000-2001.

Year	Population Estimate	5 Year Moving Average of Population Estimate	Cohort Replacement Rate	5 Year Moving Average of Cohort Replacement Rate
1986	2596	-	0.27	-
1987	2186	-	0.20	-
1988	2886	-	0.07	-
1989	697	-	1.78	-
1990	431	1759	0.90	0.64
1991	211	1282	0.88	0.77

1992	1241	1093	1.04	0.93
1993	387	593	3.45	1.61
1994	186	491	4.73	2.20
1995	1287	662	2.33	2.49
1996	1337	888	1.71	2.65
1997	880	815	1.54	2.75
1998	3005	1339	1.84	2.43
1999	2288	1759	-	-
2000	1352	1772	-	-
2001	5521	2609	-	-

3. Factors Affecting the Survival and Recovery of the Species

Numerous factors contributed to the decline of winter-run Chinook salmon by degrading spawning, rearing, and migration habitats. The primary impacts include warm water releases from Shasta Dam, juvenile and adult passage constraints at RBDD, water exports in the south Delta, heavy metal contamination from Iron Mountain Mine, and entrainment in a large number of unscreened or poorly screened water diversions. Secondary factors include smaller water manipulation facilities and dams, loss of rearing habitat in the lower Sacramento River and the Delta from levee construction, marshland reclamation, and interaction with and predation by introduced species (NMFS 1997).

Since the listing of winter-run Chinook salmon, many habitat problems that led to the decline of the species have been addressed and improved through restoration and conservation actions.

The impetus for initiating restoration actions stem primarily from ESA temperature, flow, and diversion requirements (e.g., NOAA Fisheries'1993 biological opinion addressing the effects of the Bureau of Reclamation's [BOR] operation of the Central Valley Project [CVP] and DWR's operation of the State Water Project [SWP] on winter-run Chinook salmon); State Water Resources Control Board (SWRCB) orders requiring compliance with Sacramento River water temperature objectives; a 1992 amendment to the authority of the CVP through the Central Valley Project Improvement Act (CVPIA) to give fish and wildlife equal priority with other CVP objectives (e.g., in section 3406[b][2], establishment of a water account to supplement CVPIA minimum flow requirements); fiscal support of habitat improvement projects from the CALFED Bay-Delta Program (e.g., installation of the Glenn-Colusa Irrigation District [GCID] fish screen, establishment of an Environmental Water Account [EWA], etc.); and EPA pollution control efforts to alleviate acidic mine drainage from Iron Mountain Mine.

Together these restoration actions have improved conditions for winter-run Chinook salmon migration, reproduction, and rearing. Water temperature requirements in the Sacramento River below Keswick Dam have improved the spawning and rearing conditions for winter-run Chinook salmon by maintaining summer waters at 56^{O} F. This water temperature results in a higher rate of successful egg development than existed under the flow regime that was in place prior to the listing of the species under the ESA.

Other changes in the operational requirements of the CVP and SWP require that the gates of the RBDD be opened and the gates at the Delta Cross Channel be closed during periods when listed salmonids are present. This change in gate operations has affected listed fish by improving migration conditions for juveniles and adults and increasing overall survival rates.

The CVPIA and the Anadromous Fish Restoration Program (AFRP) have benefitted winter-run Chinook salmon by funding and implementing actions that improve anadromous fish habitat. Section B2 of the CVPIA created water accounting system to provide water for anadromous fish, and to improve water quality in the Delta. B2 water is commonly used to minimize the effects of flow fluctuations by supplementing CVPIA minimum flow requirements. This benefits fish by minimizing flow fluctuations and flow reductions in the upper Sacramento River, and by creating conditions that improve outmigrant survival in the Delta. Numerous actions have been funded by the AFRP to increase winter-run Chinook salmon production, including acquisition of Sacramento River riparian habitat, increased law enforcement, fish screens at major Sacramento River diversions, and spawning gravel augmentation.

The CALFED Bay-Delta Program (CALFED) has funded numerous restoration projects that benefit winter-run Chinook salmon, including a state of the art fish screens and fish passage designs at Anderson-Cottonwood Irrigation District (ACID) diversion and dam, Glenn-Colusa Irrigation District (GCID), Reclamation District 108, Princeton-Cordura-Glenn & Provident Irrigation District, and other smaller diversions. These project have reduced the entrainment of outmigrants into diversions. CALFED also established an Environmental Water Account (EWA) in increase protection of anadromous fish through better management of Central Valley Water. The account buys water from willing sellers or diverts surplus water when safe for fish, then banks, stores, transfers and releases it as needed to protect fish and compensate water users. EWA managers also coordinate with water project operators to curtail pumping at specific times to avoid harming fish.

Since 1986, the Federal Environmental Protection Agency (EPA) has implemented remedial actions at Iron Mountain Mine. The completion of a lime neutralization plant is successfully removing significant concentrations of toxic metals in acidic mine drainage from the Spring Creek Watershed. According to the EPA, the existing pollution control system removes up to 75% of the toxic compounds emitted from the mine. A large dam currently under construction on Slickrock Creek will ultimately enable a 95% toxicity reduction. Improvement of water quality below Keswick Dam has contributed to higher survival rates of adult and juvenile winter-run Chinook salmon, and minimized the likelihood of large toxic releases and fish kills.

4. Likelihood of Survival and Recovery

Recent trends in winter-run Chinook salmon abundance and cohort replacement are positive and indicate some recovery since the listing, however, the population still remains susceptible to extinction because of low abundance and the reduction of their genetic pool to one population.

B. Central Valley Spring-Run Chinook Salmon

1. Background and Life History

NOAA Fisheries listed the Central Valley spring-run Chinook salmon evolutionarily significant unit (ESU) as threatened on September 16, 1999 (64 FR 50394). Historically, spring-run Chinook salmon were the dominant run in the Sacramento River Basin, occupying the middle and upper elevation reaches (1,000 to 6,000 feet) of most streams and rivers with sufficient habitat for over-summering adults (Clark 1929). Clark estimated that there were 6,000 miles of salmon habitat in the Central Valley Basin (much which was high elevation spring-run Chinook salmon habitat) and that by 1928, 80% of this habitat had been lost to dam construction and mining. Yoshiyama et al. (1996) determined that, historically, there were approximately 2,000 miles of salmon habitat available prior to dam construction and mining and that only 18% of that habitat remains.

Adult spring-run Chinook salmon enter the Delta from the Pacific Ocean beginning in January and enter natal streams from March to July. In Mill Creek, Van Woert (1964) noted that of 18,290 spring-run Chinook salmon observed from 1953 to 1963, 93.5 percent were counted between April 1 and July 14, and 89.3 percent were counted between April 29 and June 30.

During their upstream migration, adult Chinook salmon require streamflows sufficient to provide olfactory and other orientation cues used to locate their natal streams. Adequate streamflows are also necessary to allow adult passage to upstream holding habitat. The preferred temperature range for upstream migration is 38E F to 56E F (Bell 1991; DFG 1998).

Upon entering fresh water, spring-run Chinook salmon are sexually immature and must hold in cold water for several months to mature. Typically, spring-run Chinook salmon utilize mid-to high-elevation streams that provide appropriate temperatures and sufficient flow, cover, and pool depth to allow over-summering. Spring-run Chinook salmon may also utilize tailwaters below dams if cold water releases provide suitable habitat conditions. Spawning occurs between September and October and, depending on water temperature, fry emergence occurs between November and February.

Spring-run Chinook salmon emigration is highly variable (DFG 1998). Some may begin outmigrating soon after emergence, whereas others oversummer and emigrate as yearlings with the onset of increased fall storms (DFG 1998). The emigration period for spring-run Chinook salmon extends from November to early May, with up to 69% of young-of-the-year outmigrants passing through the lower Sacramento River between mid-November and early January (Snider and Titus 2002). Outmigrants are also known to rear in non-natal tributaries to the Sacramento River, and the Delta (DFG 1998).

Chinook salmon spend between one and four years in the ocean before returning to their natal streams to spawn (Myers et al. 1998). Fisher (1994) reported that 87% of Chinook trapped and examined at RBDD between 1985 and 1991 were three-year-olds.

2. Population Trends

Spring-run Chinook salmon were once the most abundant run of salmon in the Central Valley (Campbell and Moyle 1991) and were found in both the Sacramento and San Joaquin drainages. More than 500,000 spring-run Chinook salmon were caught in the Sacramento-San Joaquin commercial fishery in 1883 alone (Yoshiyama et al. 1998). The San Joaquin populations were essentially extirpated by the 1940s, with only small remnants of the run that persisted through the 1950s in the Merced River (Hallock and Van Wort, 1959, Yoshiyama et al. 1998). Populations in the upper Sacramento, Feather, and Yuba Rivers were eliminated with the construction of major dams during the1950s and 1960s. Naturally spawning populations of spring-run Chinook salmon are currently restricted to accessible reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Mill Creek, Feather River, and the Yuba River (DFG 1998).

Since 1969, the spring-run Chinook salmon ESU has displayed broad fluctuations in abundance, ranging from 1,403 in 1993 to 25,890 in 1982 (DFG unpublished data). The average abundance for the ESU was 12,590 for the period of 1969 to 1979, 13,334 for the period of 1980 to 1990, and 6,554 from 1991 to 2001. Evaluating the abundance of the ESU as a whole, however, masks significant changes that are occurring among metapopulations. For example, although the mainstem Sacramento River population has undergone a significant decline, the tributary populations generally have demonstrated a substantial increase. Average spring-run Chinook salmon abundance in the mainstem Sacramento River has declined from a high of 12,107 for the period of 1980 to 1990, to a low of 629 from 1991 to 2001, while the average abundance of Sacramento River tributary populations increased from a low of 1,227, to a high of 5,925 over the same period. Tributaries such as Mill and Deer Creeks have shown positive escapement trends since 1991, yet recent escapements to Butte Creek, including 20,259 in 1998, 9,605 in 2001 and 8,785 in 2002, are responsible for the magnitude of tributary abundance (DFG 2002 and DFG unpublished spring-run Chinook salmon data 2002). Although recent tributary production is promising, annual abundance estimates display a high level of fluctuation and the overall number of CV spring-run Chinook salmon remains well below estimates of historic abundance.

3. Factors Affecting the Survival and Recovery of the Species

The initial factors that led to the decline of spring-run Chinook salmon were related to the loss of upstream habitat behind impassible dams. Since this initial loss of habitat other factors have contributed to the decline of Chinook salmon and affected the ESU's ability to recover. These factors include a combination of physical, biological, and management factors such as climatic variation, water management, hybridization, predation, and harvest (DFG 1998).

Weather and ocean conditions in California can vary substantially from year to year. During the drought of 1984 to 1992, spring-run Chinook salmon populations declined substantially. Low flows and warm water temperatures impacted adults, juveniles, and eggs reducing fecundity, development and survival. For adult spring-run Chinook salmon, reduced instream flows delayed or completely blocked access to holding and spawning habitats and may have reduced fecundity. Water management operations, including reservoir releases, and unscreened and poorly screened diversions in the Sacramento River and it's tributaries, and the Delta compounded drought-related problems by reducing river flows, warming river temperatures, and entraining juvenile spring-run Chinook salmon.

Hatchery practices as well as spatial, and temporal overlaps of habitat use and spawning activity between spring- and fall-run led to the hybridization and homogenization of some subpopulations (DFG 1990). As early as the 1960s, Slater (1963) observed that early fall-run were competing with spring-run Chinook salmon for spawning sites in the Sacramento River below Keswick Dam and speculated that the two runs may have hybridized. Feather River hatchery spring-run Chinook salmon have been documented as straying throughout Central Valley streams for many years (DFG 1997), and in many cases have been recovered from the spawning grounds of fall-run Chinook (Colleen Harvey Arrison, DFG, pers. comm., 2002), an indication that Feather River Hatchery spring-run Chinook salmon may exhibit fall-run life history characteristics. Although the degree of hybridization has not been comprehensively determined, it is clear that the populations of spring-run Chinook salmon spawning in the Feather River and counted at RBDD contain hybridized fish. The hybridization of these stocks is thought to result in genetic dilution of stocks, and production of progeny that do not show an affiliation to a particular run type.

Accelerated predation may also be a factor in the decline of spring-run Chinook salmon. Although predation is a natural component of spring-run Chinook salmon life ecology, the rate of predation likely has greatly increased through the introduction of non-native predatory species such as striped bass and largemouth bass, and through the creation of flow regimes and structures (i.e., dams, bank revetment, bridges, diversions, piers, and wharfs) that attract predators (Stevens 1961, Vogel et al. 1988, Garcia, 1989, Decato 1978). The FWS found that more predatory fish were found at rock revetment bank protection sites between Chico Landing and Red Bluff than at sites with naturally eroding banks (Michny and Hampton 1984). On the mainstem Sacramento River, high rates of predation are known to occur at RBDD, ACID, GCID, and at south Delta water diversion structures (DFG 1997). From October 1976 to November 1993, DFG conducted ten mark/recapture experiments at the SWP's Clifton Court Forebay to estimate pre-screen losses using hatchery-reared juvenile Chinook salmon. Pre-screen losses ranged from 69% to 99%. Predation from striped bass is thought to be the primary cause of the loss (DFG 1997, Gingras 1997).

Spring-run Chinook salmon are harvested in ocean commercial, ocean recreational, and inland recreational fisheries. Coded wire tag returns indicate that Sacramento River salmon congregate off the coast between Point Arena and Morro Bay. Ocean fisheries have affected the age structure of spring-run Chinook salmon through targeting large fish for many years and reducing the number of four and five year olds (DFG 1997). An analysis of six tagged groups of Feather River Hatchery spring-run Chinook salmon by Cramer and Demko (1997) indicates that harvest rates of three-year-old fish ranged from 18% to 22%, four-year-olds ranged from 57% to 84%, and five-year-olds ranged from 97%-100%. Reducing the age structure of the species reduces it's resiliency to factors that may impact a year class. In-river recreational fisheries have historically taken fish throughout the species' range. During the summer, holding adult spring-run Chinook salmon are easily targeted by anglers when they congregate in large pools. Poaching also occurs at fish ladders, and other areas where adults congregate, however, the level of poaching on the adult population is unknown.

Several actions have been taken to improve habitat conditions for spring-run Chinook salmon, including improved management of Central Valley water (e.g., through use of CALFED EWA and CVPIA (b)(2) water accounts) and new and improved screen designs at major water diversions along spring-run Chinook salmon tributaries and the mainstem Sacramento River, and changes in ocean and inland fishing regulations to minimize harvest. These actions have benefitted spring-run Chinook salmon in much the same way that they have benefitted winter-run Chinook salmon including improving adult and juvenile migration conditions, increasing adult and juvenile survival, and minimizing harvest. Temperature criteria also benefits rearing spring-run Chinook salmon and steelhead below Keswick Dam by creating conditions that increase survival by eliminating large changes in daily summer water temperature. Similarly, water temperature requirements in Clear Creek, below Whiskeytown Dam, and in the low flow Channel of the Feather River have improved the rearing conditions that increase the survival of spring-run Chinook salmon and steelhead by minimizing large temperature variations and periods of high temperatures.

4. Likelihood of Survival and Recovery

Although protective measures likely have led to recent increases in spring-run Chinook salmon abundance, the ESU is still below levels observed from the 1960s through 1990. Threats from hatchery production, climatic variation, predation, and water diversions persist. Because the spring-run Chinook salmon ESU is confined to relatively few remaining streams and continues to display broad fluctuations in abundance, the population is at a moderate risk of extinction.

C. Central Valley Steelhead

1. Background and Life History

NOAA Fisheries listed the CV steelhead ESU as threatened on March 19, 1998 (63 FR 13347). The ESU includes all naturally-produced CV steelhead in the Sacramento-San Joaquin River Basin. NOAA Fisheries published a final 4(d) rule for steelhead on July 10, 2000 (65 FR 42422).

All steelhead stocks in the Central Valley are winter-run steelhead (McEwan and Jackson 1996). Steelhead are similar to Pacific salmon in their life history requirements. They are born in fresh water, emigrate to the ocean, and return to freshwater to spawn. Unlike other Pacific salmon, steelhead are capable of surviving after they spawn, swimming to the ocean, and returning to spawn again in subsequent years.

The majority of the steelhead spawning migration occurs from October through February and spawning occurs from December to April in streams with cool, well oxygenated water that is available year round. Van Woert (1964) observed that in Mill Creek, the steelhead migration is continuous, and although there are two peak periods, sixty percent of the run is passed by December 30. Similar bimodal run patterns have also been observed in the Feather River (Ryan Kurth, DWR, pers. comm., 2002), and the American River (John Hannon, BOR, pers. comm., 2002).

Incubation time is dependent upon water temperature. Eggs incubate for one and a half to four months before emerging. Eggs held between 50º and 59º F hatch within three to four weeks (Moyle 1976). Fry emerge from redds within four to six weeks depending on redd depth, gravel size, siltation, and temperature (Shapovalov and Taft 1954). Newly emerged fry move to shallow stream margins to escape high water velocities and predation (Barnhart 1986). As fry grow larger they move into riffles and pools and establish feeding locations. Juveniles rear in freshwater for one to four years (Meehan and Bjornn 1991) emigrating episodically from natal springs during fall, winter and spring high flows (Healey 1991). Steelhead typically spend two years in fresh water. Adults spend one to four years at sea before returning to freshwater to spawn as four or five year olds (Moyle 1976).

2. Population Trends

Steelhead historically were well-distributed throughout the Sacramento and San Joaquin Rivers (Busby et al. 1996). Steelhead were found from the upper Sacramento and Pit River systems south to the Kings and possible the Kern River systems and in both east- and west-side Sacramento River tributaries (Yoshiyama et al. 1996). The present distribution has been greatly reduced (McEwan and Jackson 1996). The California Advisory Committee on Salmon and Steelhead (1988) reported a reduction of steelhead habitat from 6,000 miles historically to 300 miles. The California Fish and Wildlife Plan (DFG 1965) estimated there were 40,000 steelhead in the early 1950s. Hallock (1961) estimated an average of 20,540 adult steelhead through the 1960s in the Sacramento River, upstream of the Feather River.

Existing wild steelhead stocks in the Central Valley are mostly confined to upper Sacramento River and its tributaries, including Antelope, Deer, and Mill Creeks and the Yuba River. Populations may exist in

Big Chico and Butte Creeks and a few wild steelhead are produced in the American and Feather Rivers (McEwan and Jackson 1996). Until recently, steelhead were thought to be extirpated from the San Joaquin River system. Recent monitoring has detected self sustaining populations of steelhead in the Stanislaus, Mokelumne, Calaveras, and other stream previously thought to be void of steelhead (McEwan 2001). It is possible that naturally spawning populations exist in many other streams but are undetected due to lack of monitoring programs (SPWT 1999).

Reliable estimates of steelhead abundance for different basins are not available (McEwan 2001), however, McEwan and Jackson (1996) estimated the total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults. Steelhead counts at the RBDD have declined from an average of 11,187 for the period of 1967 to 1977, to an average of approximately 2,000 through the 1990s (McEwan and Jackson 1996, McEwan 2001).

3. Factors Affecting the Survival and Recovery of the Species

The factors affecting the survival and recovery of CV steelhead are similar to those affecting winter- and spring-run Chinook salmon and are primarily associated with habitat loss (McEwan 2001). McEwan and Jackson (1996) attribute this habitat loss and other habitat problems primarily to water development resulting in inadequate flows, flow fluctuations, blockages, and entrainment into diversions. Other habitat problems related to land use practices and urbanization have also contributed to steelhead declines (Busby et al. 1996). Although many of the factors affecting salmon also affect steelhead, some stressors, especially summer water temperatures cause greater effects to steelhead because juvenile steelhead rear in freshwater for more than one year. Suitable steelhead conditions primarily occur in mid to high elevation streams. Because most suitable habitat has been lost to dam construction, juvenile rearing is generally confined to lower elevation stream reaches where water temperatures during late summer and early fall can be high.

Many of the habitat improvements that have benefitted winter- and spring-run Chinook salmon, including water management through the CVPIA (b)(2) water supply and the CALFED EWA, improved screening conditions at water diversions, and changes in inland fishing regulations (there is no ocean steelhead fishery) benefit CV steelhead, however, many dams and reservoirs in the Central Valley do not have water storage capacity or release mechanisms necessary to maintain suitable water temperatures for steelhead rearing through the critical summer and fall periods, especially during critically dry years (McEwan 2001).

4. Likelihood of Survival and Recovery

The future of CV steelhead is uncertain because of the lack of trend data.

IV. ENVIRONMENTAL BASELINE

The environmental baseline is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species, its habitat (including designated critical habitat), and ecosystems within the action area (FWS and NMFS 1998).

A. Description of the Action Area

The action area is defined as all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR § 402.02). The action area for the proposed project includes the area directly affected by the fish sampling and the upstream and downstream points in the SDWSC at which non-tidal flow changes can be detected as a result of manipulating lock gates. Flow change detection will serve as a surrogate for evaluating false attraction of adult salmon and steelhead to the SDWSC, and diversion of juvenile salmon and steelhead into the SDWSC from the Sacramento River. Fish sampling activities will be confined to an area no more than 500 feet upstream of the upper lock gate and 500 feet downstream of the lower lock gate. Flow simulation modeling indicates that the downstream point in which project related flows will be detected is located approximately two miles upstream of the confluence of the SDWSC and the Sacramento River near Cache Slough. Flow modeling also shows that the largest diversion of flow volume from the Sacramento River expected as a result of project scenarios is less than 0.2% of monthly Sacramento River discharge when January 1997 flows are simulated. Since the January 1997 flow is one the highest on record and the research project will discontinue sampling during high water periods, the modeling suggests that implementation of research scenarios will not result in detectable change in the flow of the Sacramento River. The action area, therefore, consists of the upper SDWSC from a point approximately 500 feet upstream of the upper gate of the W.G. Stone Lock, downstream to a point approximately two miles upstream of the confluence with the Sacramento River near Cache Slough.

B. Status of the Listed Species Within the Action Area.

Estimates of the number of salmon and steelhead that enter the SDWSC and follow it upstream to the lock is unknown. However, existing information indicates that adult Chinook salmon and steelhead migrate into the action area and their upstream passage is blocked by the W.G. Stone Locks. Observations by DWR biologists indicate that adult salmon that migrate into the upper SDWSC hold below the W.G. Stone Lock, possibly attracted to the small of amount of Sacramento River water leaking through an eight-inch crack in the gates (Maureen McGee, DWR, pers. comm., 2002)

Fisheries investigations conducted by the FWS in the upper section of the SDWSC from May 1994 to November 1994, using gill nets, otter trawls, and angler surveys, found that adult Chinook salmon are present behind the lock throughout the summer and fall months, and are likely to be present year-round

(FWS 1995). The only other known fish sampling efforts in the SDWSC were conducted on an intermittent basis by DFG using gill nets, otter trawls, and angler surveys. These efforts recorded two Chinook salmon and one steelhead in 1973, one steelhead in 1974, five Chinook salmon and two steelhead in 1975, one Chinook salmon in 1976, and ten Chinook salmon in 1993. In 1994, 90 fall-run Chinook salmon were radio-tagged and released in the Suisun Bay as part of an Interagency Ecological Program (IEP) migration study; one of these fish was subsequently detected in the upper SDWSC. In 2001, a fall-run Chinook salmon radio tagged in Montezuma Slough, as part of an IEP study, was also detected in the upper Deep Water Ship Channel (Maureen McGee, DWR, pers. comm., 2002).

Juvenile Chinook salmon and steelhead outmigrate past the upstream entrance to the SDWSC from late fall to spring. Snider and Titus (2000) observed that juvenile salmon emigrate in three phases. The first phase is the initiation of emigration that is strongly linked to initial Sacramento River flow increases between mid-November and early January. Approximately 78% of winter-run Chinook salmon and 69% of spring-run Chinook salmon emigrate during this phase. The second phase is characterized by sustained high Sacramento River flows between early January and early March and is dominated by approximately 68% of the naturally produced fall-run Chinook salmon. The third phase typically occurs one week after the release of fall-run Chinook salmon from the Coleman National Fish Hatchery and is dominated by fish from that facility. Juvenile steelhead emigration primarily occurs during the second and third phases.

C. Factors Affecting Species Within the Action Area.

The primary factors affecting the species within the action area include freshwater flows through the lock, tidal exchange, water temperatures, water quality, riparian habitat, angler harvest, and predation. These contributing factors may affect listed anadromous fish by creating false attraction flows, blocking adult salmon behind the lock gates, creating unfavorable juvenile outmigration conditions, and reducing the number of individuals that escape to the Pacific Ocean or to spawn.

Regular operation of the W.G. Stone Lock in West Sacramento began in 1963 and ceased in 1982 when it was put into caretaker status due to low commercial use. From 1973 to 1982 the lock was operated for 12 to 16 hours per day due to a decline in use. The City of Sacramento operated the lock occasionally for recreational boating until 1987. From 1987 to 1999, the lock was only opened for maintenance and inspection. In 2000, the Corps de-authorized the lock, only spending funds on the facility for reasons of public safety. The lock is currently in a closed position. However, there is a small amount of leakage through the lock gate seals.

Fresh water enters the SDWSC primarily through the W.G. Stone Lock. Prior to the lock gates being closed, up to 30,000 acre feet (af) of Sacramento River water was diverted into the SDWSC each year through the lock. Water levels in the channel currently are driven by tidal action, with tidal exchanges moving approximately 1200 acre-feet of water per cycle. The average tidal range for the Sacramento River on the upstream side of the lock is approximately 2.5 feet during periods of low flow.

When the lock gates are open, water levels in the SDWSC can be affected by river stage. When the locks are closed, leaks in the lock seals contribute some fresh water to the channel and are thought to be creating a small attraction flow (<1 cfs) for adult Chinook salmon and steelhead. Prior to the reduced operation of the lock, flow diversions through the SDWSC probably created a greater attraction to adult salmon and steelhead, which may have successfully continued their upstream migration through the channel and into the Sacramento River when the lock gates were opened. Although discontinued use of the lock has probably reduced the attraction of salmonids to the upper SDWSC, a limited, yet unknown number of fish, currently enter the channel and are observed staging below the locks (DWR 2002).

The fate of salmon and steelhead that migrate into the upper SDWSC is not completely understood. Prior to ceasing lock gate operations, fish could pass through to the Sacramento River when the gates were opened for navigation purposes. In at least one instance several hundred fish moved upstream through the lock when the gates were opened (Corps 1995). Salmon and steelhead blocked behind the lock gates are thought to be harvested by anglers, or die without spawning (FWS 1995). It is unknown whether or not any of the salmon and steelhead that migrate up the SDWSC to the W.G. Stone Locks and find their migration interrupted are able successfully retrace their path and swim 25 miles downstream to re-enter the Sacramento River. However, given the distance a fish would have to backtrack in order to resume upstream migration in the Sacramento River, this behavior seems unlikely. Mortalities below the lock and the effects of delayed upstream migration likely reduce the number of adult salmon and steelhead that successfully spawn.

Curtailed use of the lock since 1982 has reduced through-channel flow and led to water quality problems in the SDWSC, including high salinity and water temperatures (Corps 1995). In 1975, the Central Valley Regional Water Quality Control Board (Regional Board) adopted a basin plan that included water quality objectives for the SDWSC. Water quality data collected between 1963 and 1983 indicated that salinity levels frequently exceeded Regional Board standards (FWS 1995).

Water temperatures in the SDWSC were recorded by the FWS (1995) from July 1994 to March 1995. Temperatures that are sublethal and lethal to juvenile and adult salmonids were observed near the lock during July and August. From July through August, the average daily water temperature exceeded 73^{O} F for all but two days. The maximum daily water temperature was 88.2^{O} F on July 26, 1994, and the highest daily average was 78.5^{O} F on July 30, 1994. Water temperatures remain above 70^{O} F until late September, and drop to below 60^{O} F by November (FWS 1995). Through the winter, temperatures range between 45^{O} F and 55^{O} F. Summer water temperatures in the upper SDWSC tend to be about 10^{O} F warmer than in the Sacramento River (Corps 1995).

Riparian vegetation and large woody debris along and within the ship channel is scarce. Emergent aquatic vegetation, comprised of bulrush cattail and three-square bulrush grows sporadically along the edge of the channel; grasses and forbs grow along the levee slopes. Most of the shoreline is covered with riprap or maintained through vegetation removal and rock applications (Corps 1995). Inchannel large woody debris shaded riverine aquatic (SRA) habitat, are important habitat components for rearing salmonids because they contribute to shade, food production, and cover from predators (FWS 2000). The sparse and sporadic distribution of SRA in the SDWSC limits the value of the channel as rearing habitat for salmon and steelhead.

Warm water temperatures, high salinities, lack of riparian vegetation, and the presence of predators combine to create conditions that are generally unfavorable to rearing and outmigrating juvenile salmonids, especially when these conditions are compared to conditions of the Sacramento River. Past investigations have considered using the SDWSC as a juvenile bypass channel to reduce the exposure of anadromous fish to the Delta Cross Channel and Georgiana Slough, where juvenile mortality rates are high (Corps 1995). However Harza (1995) and (FWS 1995) concluded that poor habitat conditions in the SDWSC, including a lack of freshwater through-flow, a lack of riparian habitat, and high levels of predation were not suitable for juvenile rearing or outmigration, and that use of the channel would likely result in higher losses than if the fish were to remain in the mainstem Sacramento River.

V. EFFECTS OF THE ACTION

The SDWSC Fish Passage Study will involve the direct take of adult and juvenile winter- and spring-run Chinook salmon, and steelhead through capture and tagging of fish trapped in trammel nets, gill nets, and purse seines, and may also result in the unintentional take of juvenile spring- and winter-run Chinook salmon, and steelhead as result of diverting Sacramento River flows into the SDWSC through the proposed operation of the lock. Adult fish are expected to be the primary life stage encountered by this study, although some juvenile fish may pass through the lock when the gates are open and either become captured in the nets, or diverted through the SDWSC. It is also possible that opening the W.G. Stone Locks will result in higher SDWSC flows that could attract increased numbers of adult salmon and steelhead.

A. Fish Capture, Handling, and Tagging

The proposed project is intended to selectively capture fish in different types of nets, and also to monitor upstream migration of adult salmonids using tagging and recapture methods, and hydroacoustic detection. According to the SDWSC Fish Passage Study Plan (DWR 2002), this approach is based on an evaluation of other fish sampling projects in the Delta that have used similar techniques to selectively capture different species of fish, including studies conducted at the Delta Cross Channel, the Sacramento River, Georgiana Slough, and Suisun Bay, by DFG, DWR, and FWS from 1973 to 2001.

Hydroacoustics uses high frequency sound to detect images. This technology is commonly applied to fish finders and depth finders and has recently been applied to count adult salmon migrating into large rivers in California, Washington, Oregon, and British Columbia (Ploskey et al. 2002). Physiological effects to fish typically occur at low frequencies and high pressures. An ongoing review by NOAA

Fisheries on the effects of sound pressure levels on salmonids has preliminarily concluded that adverse effects occur at sound pressure levels between 140 and 150 dB (Jeff Stuart, NOAA Fisheries, pers. comm., 2003) The frequency threshold for fish hearing is approximately 0.5 kHz to 5 kHz (Scholik and Yan 2000, Scholik and Yan 2002). The frequency used in hydroacoustics can range between 100 and 200 kHz and does not generate a measurable sound pressure wave. Because the sound frequency is not detectable by salmonids and there will not be a measurable sound pressure change, the use of hydroacoustics is not expected to have any adverse effects on listed salmonids.

DWR anticipates that adult salmon and steelhead are most likely to be captured in trammel nets and possibly gill nets. Juvenile salmon and steelhead are expected to be captured in purse seines. Several factors affect fish that are trapped in nets. Mesh size, inspection frequency, fish handling experience of biologists, water temperatures, and fish condition all influence whether captured fish can be returned to water with low stress and mortality.

Fish captured in trammel nets generally remain in better physical condition than those captured in gill nets. With trammel nets, loose panels of soft netting wrap around a fish minimizing the chaffing and entanglement of body parts (Murray 1983). Fish sampling projects conducted by DWR biologists working in Suisun Bay have captured adult salmonids in trammel nets and released them with average injury rates below 5% and mortality rates below 3% (Maureen McGee, DWR, pers. comm., 2002). They anticipate similar injury and mortality rates at the SDWSC Fish Passage Project because environmental conditions at the SDWSC are similar to those in Suisun Bay and because trammel nets will be inspected every 20 minutes.

Gill nets capture fish that swim partway through the net and are unable to back out because they become entangled by their teeth, operculum, or fins (Murray 1983, ODFW 1996). Of three gill net mesh sizes used to capture adult Chinook salmon in Alaska, the larger mesh (8-inch) was most effective at capturing large salmon, but was more harmful to fish than the smallest mesh size (5 1/8-inch). Most fish captured in the 5 1/8-inch mesh gill nets were entangled rather than gilled (ODFW 1996). DWR proposes to use a gill net comprised of both 6-inch and 10-inch mesh. Fish captured in the 10-inch mesh are more likely to be gilled, whereas fish that encounter the 6-inch mesh are likely to be entangled. Because of the potential for gilling and entanglement, NOAA fisheries expects that salmon captured in gill nets will be more adversely affected than fish captured in trammel nets. However, DWR's proposed placement of gill nets immediately along the bottom of the SDWSC in order to target sturgeon should result in a lower proportion of salmon captured in gill nets than trammel nets because they will sample a smaller amount of the water column and encounter fewer fish. Frequent net inspections, at 20 minute intervals, will minimize injury, and immediate and delayed mortality rates for gill netted salmon by reducing fish exposure to the net and minimizing stress.

Juvenile salmonids that swim out of the Sacramento River into the action area may be captured in purse seines. Fish that are captured in purse seines will be gathered to the rear of the net and released immediately. Size assessments of juvenile salmon and steelhead captured in the American River (Snider and Titus 2001) and in the Sacramento River at Knights Landing (Snider and Titus 2000) indicate that with the exception of outmigrating fry from the American River, listed juvenile salmonids in the SDWSC should range from 50 to 300 mm, large enough so that they should not become entangled or gilled in the mesh of the net. Salmonid mortality should be minimized by returning fish quickly to the water without tagging them. Injuries will contribute to the estimated mortality rates although some may result in undetectable delayed mortality.

Floy tagging affects fish by causing lesions and delayed mortality. McCallister et al. (1992) found that dorsally inserted floy tags caused lesions in rainbow trout that were detectable up to nine months after tagging, but did not find any delayed mortality. Pierce and Tomcko (1993) showed that delayed mortality rates in northern pike were dependant upon fish condition at the time of handling. Mortality rates for northern pike that were able to maintain an upright position at the time of tagging were 2.4%, compared to 72.7% for pike that were unable to right themselves. In general, the effects of tagging are dependant upon the physical condition of the fish at the time of release (Wyodski and Emery 1983). Fish that are handled carefully, held in fresh water, and released quickly would be expected to recover at high rates. However, a high percentage of fish tagged in poor condition and unable to maintain an upright position would be expected to die.

In a previous study of salmonid presence in the SDWSC, the FWS (1995) reported the condition of captured adult fall-run Chinook salmon varied from very active to moribund. The poor condition was attributed to the amount of time fish spent in the SDWSC prior to capture since all fish were removed from the nets as soon as they were detected. During the project, water temperatures exceeded 70º f in the late-summer and early-fall and probably taxed the physiological thresholds of the fall-run Chinook salmon. At water temperature above 65º F, salmonid metabolic rate increases, as does metabolic demand (Boles 1988). The combination of increased energy expenditure associated with a higher metabolic rate and high water temperatures can result in toxic accumulations of lactic acid and stress hormone (Myrick and Cech 2001). During the months that spring- and winter-run Chinook salmon and a majority of steelhead (i.e., those that migrate from October through May) are expected in the action area, past investigations conducted by the FWS in the SDWSC indicate that water temperatures will be below 60º F (FWS 1995). Therefore, physiological stressors should be low and the number of listed adult salmonids that die from capture, handling, and tagging due to the proposed project should be low (see Table 1). Additionally, proposed placement of gill nets on the bottom of the SDWSC in order to target sturgeon should result in fewer salmon captured in gill nets than trammel nets. Frequent net inspections (i.e., at 20 minute intervals) should minimize mortality of netted salmon.

To determine the amount of take for the proposed research project, DWR evaluated the lethal and non-lethal take per unit of effort of similar projects in the Delta that capture adult salmonids, and applied that take rate to the SDWSC Fish Passage Project. DWR anticipates capturing a total of 675 listed adult salmonids from May 2003 to May 2005, with 232 of these fish being adult winter-run Chinook salmon, 180 adult being spring-run Chinook salmon, and 123 being steelhead. The average adult mortality rate anticipated by DWR, for all species combined, is less than 3%. The adult injury rate will be 100% since all captured fish that are capable of maintaining an upright position will be tagged. Based on juvenile encounter rates of similar field studies previously carried out by DWR, and because lock operation will be conducted to minimize juvenile fish diversion into the SDWSC by coordinating lock operations with the DAT team (see discussion below), DWR anticipates capturing 69 juvenile winter-run Chinook salmon, 55 juvenile spring-run Chinook salmon, and 16 juvenile steelhead, with an anticipated average mortality rate, for all species combined, of less than 7% and an injury rate of less than 2%.

B. Lock Operation

Opening the W.G. Stone Locks will facilitate the upstream passage of adult salmonids, but may also divert juvenile salmon from the Sacramento River downstream into the SDWSC or attract increased numbers of adult salmon upstream into the SDWSC.

Opening the lock gates could potentially divert juvenile salmon and steelhead from the Sacramento River into the SDWSC. Flow modeling showed that the largest monthly increase in flow diverted from the Sacramento River expected from implementing Scenarios 1 and 2, is less than 0.2% during a wet year (Harrison 2002). Assuming that outmigrating juvenile salmonids passively follow river flows as they move downstream, and following the observations of Hallock and Van Woert (1959) that outmigrating juvenile salmon are uniformly distributed across the Sacramento River from the surface down to four feet, a low, but unknown number of juvenile salmon and steelhead are anticipated to be diverted into the SDWSC if diversion flows represent less than 0.2% of the overall river flow. The number of juveniles that will be diverted into the SDWSC also is expected to be low because the SDWSC mouth is oriented slightly downstream and has a sand deposit blocking much of its entry. Because of this orientation and sand deposit, water is not directly diverted into the SDWSC from the Sacramento River, but backs into the mouth of the SDWSC and moves through the locks as a result of head differential. Downstream migrating juveniles would have to actively swim into the SDWSC entry in order to be diverted through the locks. Adult and salmon and steelhead are not expected to follow diversion flows and be drawn into the entrance of the SDWSC because they primarily are following cues that lead them upstream.

Any juvenile salmonids that are diverted into the locks would have to swim downstream through the SDWSC or swim back upstream through the W.G. Stone Locks in order to continue their migration to the Pacific Ocean. Numerous studies have documented lower survival rates for outmigrating juvenile salmonids that are diverted from the Sacramento River into the central Delta via the Delta Cross Channel and Georgian Slough (Kjelson et al. 1990, FWS 1992, Hanson 1996). Reduced survival rates are caused by migration delays, increased predation, and exposure to elevated water temperatures (Hanson 1996). Because of the low quality rearing habitat in the SDWSC, conditions are probably similar to those found in the central Delta and are likely to cause higher juvenile mortality than would be expected in the Sacramento River. This could result in a reduction of numbers that escape to the Pacific Ocean.

In order to determine if the research project scenarios will increase the likelihood of falsely attracting adult Chinook salmon and steelhead into the SDWSC, DWR conducted five Delta Simulation Model II runs to simulate changes in the lock openings and assess the hydrodynamic impacts of opening the lock by various widths (Harrison 2002). The model runs used the 1997 water year (October 1996 - October 1997) and actual tides, hydrologic conditions, and Delta configurations were applied. The five runs, respectively included the following conditions: 1) gates entirely closed, 2) gates closed but with an eight-inch leak, and 3) to 5) gates open at either two feet, four feet, or six feet for two hours per day, 3 days per week, with an eight-inch leak when closed. The five model runs represent a variety of hydrologic and operation conditions that could be expected to occur under Scenarios 1 and 2 during a wet year. A wet year was selected for the model runs because it was anticipated by DWR and NOAA Fisheries to have the greatest effect on the environmental conditions that influence anadromous fish migration. Because the gates do not fully close, the eight-inch leak was intended to mimic existing baseline conditions.

Flow simulation modeling indicates that less than a 1.5% maximum change in tidally-averaged flows is expected at the downstream end of the SDWSC (i.e., approximately 2 miles upstream from the confluence with the Sacramento River, and 22 miles downstream of the W.G. Lock). The highest simulated flow change occurred during a high Sacramento River flow while mimicking the desired study parameters for Scenario 2 of the proposed action; Scenario 2 is expected to have the highest diversion rate. All other model runs were below a 1% change. These simulations indicate that if the research project is suspended during high Sacramento River flows (i.e., when the river stage at I Street Bridge is greater than 25 feet), study flows generally will attenuate before they reach the Sacramento River and should not be detectable to adult salmonids, relative to baseline conditions.

In order to minimize effects to listed anadromous species, DWR proposes to coordinate with NOAA Fisheries and the DAT and suspend research activities and close the W.G. Stone Locks when significant pulses of juveniles are migrating past the action area in the Sacramento River. DWR will notify NOAA Fisheries prior to opening the W.G. Stone Lock gates when Sacramento River flows, measured at the Verona gauge, exceed 15,000 cfs between November 15 and January 1. DWR will also suspend research activities and close the locks during any time of the year when the Sacramento River stage elevation measured at the I Street Bridge reaches 25 feet (i.e., when flow is approximately 60,000 cfs at the Verona Gauge). Suspending the project at flows greater than 60,000 cfs will minimize attraction of adults from the Sacramento River and Cache Slough into the SDWSC as well as minimize diversion of juveniles in the SDWSC from the Sacramento River. This measure will minimize flow diversions during the peak outmigration period of juvenile winter- and spring-run Chinook salmon.

VI. CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, or local private actions that are reasonably certain to occur within an action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Lands adjacent to the SDWSC presently are used for agriculture and residential development. Population growth in the Sacramento and West Sacramento areas is expected to lead to increased residential development, which will displace farm land and reduce the amount of water used for irrigation. This will reduce the amount of agricultural return flow that enters the SDWSC, but lead to an increase in impervious surfaces (e.g., roads, sidewalks, roofs, etc.) that likely will affect storm water runoff patterns, quality, and quantity. The effect of these changes on listed fish and their habitat is unknown at this time, mainly because so little is known about the current use of SDWSC by fish. However, impaired water quality runoff patterns are expected to further degrade the suitability of habitat within the SDWSC.

VII. INTEGRATION AND SYNTHESIS OF EFFECTS

A. Impacts of the Proposed Action on Sacramento River Winter-run Chinook Salmon, Central Valley Spring-run Chinook Salmon, and Central Valley Steelhead

The adverse effects of the proposed action on winter-run Chinook salmon, spring-run Chinook salmon, and CV steelhead within the action area include injury, stress, and mortality related to capture, handling and tagging. Based on the take estimates provided by DWR, an overall mortality rate of 3% is anticipated for captured adults, and 7% for captured juveniles. DWR estimates that injury rates will 100% for adults and less than 2% for juveniles. Injuries will contribute to the estimated mortality rates although some may result in undetectable delayed mortality.

Juvenile winter- and spring-run Chinook salmon and CV steelhead may also be affected by the project if they stray into the SDWSC while the lock gates are open. The potential for this to occur is expected to be highest from November through January, during the peak of the lower Sacramento River juvenile winter- and spring-run Chinook salmon outmigration. The potential for take of outmigrating juvenile CV steelhead is expected to be highest from January through May, during high Sacramento River flows, when juvenile steelhead may be utilizing side channels and sloughs to escape high flood flows.

Due to poor habitat conditions in the SDWSC, the survival of juveniles that enter the SDWSC is expected to be lower than if they were to remain in the Sacramento River. This would result in a small reduction in the numbers of smolts that reach the Pacific Ocean. Although unmeasurable, the abundance of juveniles that will stray into the SDWSC and be diverted into the locks is expected to be low because the orientation of the SDWSC and a sand deposit at the mouth of the channel would require downstream migrating juveniles to depart from their normal outmigration route in the

Sacramento River, and actively swim into the SDWSC. Suspending the project and closing the lock gates between November 15 and January 1 when Sacramento River flows (measured at the Verona Gauge) exceed 15,000 cfs, and the highest proportion of the winter- and spring-run juveniles are outmigrating, will minimize the number of listed salmonids that could divert into the SDWSC. Because of their larger size and better swimming ability, juvenile steelhead are more likely to stay in the main channel of the Sacramento River and less likely than smaller juvenile salmon to swim into the SDWSC.

The beneficial effects of the proposed project include a temporary improvement of adult fish passage from May 2003, to May, 2005, and an improved understanding of the lock operations necessary to successfully pass anadromous salmonids upstream through lock gates and into the Sacramento River. During this period, adult fish that otherwise would have remained trapped behind the W.G. Stone Locks in the SDWSC will be able to move through the locks into the Sacramento River. Because of this, the number of adult salmon and steelhead that die as a result of handling and tagging will likely be lower than if the fish were to have remained trapped behind the W.G. Stone Locks. NOAA Fisheries expects that the net result of the project, when compared to baseline conditions, will be a temporary increase in the number of adult fish that escape the SDWSC to the Sacramento River.

B. Impacts of the Proposed Action on ESU Survival and Recovery

The reduction in numbers associated with the proposed action is not expected to result in a decreased potential for ESU survival and recovery for several reasons. First, there will be reduction in adult numbers within the action area due to capture, handling, and tagging mortality but there will also be a corresponding increase in the number of fish that escape the SDWSC to the Sacramento River and continue upstream migration through the Sacramento River to spawn. Second, the reduction in numbers associated with the diversion of juvenile salmonids from the SDWSC is expected to be a low percentage relative to the ESU because the slight downstream alignment of the mouth of SDWSC and the presence of a sand deposit at the head of the SDWSC will not create conditions that would be expected to actively divert juveniles, and because DWR will coordinate with NOAA Fisheries and the DAT prior to opening the lock gates between November 15 and January 1 when Sacramento River flows (measured at the Verona Gauge) exceed 15,000 cfs in order to avoid pulses of outmigrating winter-and spring-run Chinook salmon juveniles. Additionally, DWR will suspend the project when flows during the remainder of the year exceed 60,000 cfs to avoid other periods of peak winter-and spring-run Chinook salmon steelhead outmigration and prevent flow increases in the SDWSC that may attract listed adult salmonids.

VIII. CONCLUSION

After reviewing the best scientific and commercial data available, the current status of endangered Sacramento River winter-run Chinook salmon, threatened CV spring-run Chinook salmon, and threatened CV steelhead, the environmental baseline for the action area, the effects of the proposed

SDWSC Fish Passage Project, and the cumulative effects, it is NOAA Fisheries' biological opinion that the issuance of an ESA section 10 (a)(1)(A) research permit for the SDWSC Fish Passage Project is not likely to jeopardize the continued existence of the above listed species.

IX. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, kill, trap, capture or collect, or to attempt to engage in any such conduct of listed species of fish or wildlife without a special exemption under the ESA. NOAA Fisheries defines the term "harm" as an act which kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation where it actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity.

The issuance of section 10(a)(1)(A) permits are for intentional take of listed Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead associated with scientific research and enhancement activities. Where there is overlap of listed salmonids in a given habitat, the permit authorizes take of all listed salmonids. Incidental take of endangered or threatened species is not anticipated. This opinion does not authorize any taking of listed species under section 10(a) or immunize any actions from the prohibitions of section 9(a) of the ESA.

X. CONSERVATION RECOMMENDATION

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. Test for correlations between the presence of juvenile salmonids and factors related to implementation of research project scenarios, such as flow through the locks, and time of year.

XI. REINITIATION OF CONSULTATION

This concludes formal consultation on the proposed issuance of an ESA section 10 (a)(1)(A) research permit for the SDWSC Fish Passage Project. Reinitiation of formal consultation is required if (1) the amount or extent of taking specified in any incidental take statement is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the action is subsequently modified in a manner that causes an effect to the listed species that was not considered in the biological opinion; or (4) a new species is listed or critical habitat is designated that may be affected by the action. In instances where the amount or extent of take is exceeded, formal consultation shall be reinitiated immediately.

Alternative methods of capturing and passing fish may be necessary if scenarios 1 and 2 are not effective. These alternatives include a false weir, barged fish ladder and hauling operation, and a fish elevator. These additional alternatives have not be considered in this biological opinion. If DWR determines that these alternatives are necessary in order to pass fish through the lock, the section 10 (a)(1)(A) permit will require an amendment, and reinitiation of section 7 consultation will be required.

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